



Autonomous Vehicles in California

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**Bernard C. Soriano, Ph.D.
Deputy Director**



Why Autonomous Vehicles

Safety

- 32,675 people killed in crashes on U.S. roadways
 - 31% of fatalities attributed to alcohol-impaired driving
 - 10% because of distracted driving
 - 28% due to speeding-related crashes
- Estimated that 94% due to human behavior
- In over 35% of fatality crashes, brakes not applied
- 2.3 million people injured in crashes

Mobility

Efficiency (time, resources, traffic flow, land use, etc.)



Autonomous Vehicles



All automakers developing technology

- Collision avoidance systems
- Advanced driver assistance systems
- Crash mitigation systems
- Self-driving systems

Technology companies and start-ups





California Legislation

Senate Bill 1298



DMV must adopt regulations setting forth requirements for:

- Manufacturers' **testing** of autonomous vehicles on public roadways
- **Operation** of autonomous vehicles on public roadways





Definitions of Autonomous Vehicle

- National Highway Traffic Safety Administration (NHTSA) defines four levels of autonomy:
 - Level 0 – No automation
 - Level 1 – Function specific automation
 - Level 2 – Combined function automation
 - Level 3 – Limited self-driving automation
 - Level 4 – Full self-driving automation
- Society of Automotive Engineers (SAE) has similar definitions, although 5 levels

Summary of Levels of Driving Automation for On-Road Vehicles

This table summarizes SAE International's levels of *driving* automation for on-road vehicles. Information Report J3016 provides full definitions for these levels and for the italicized terms used therein. The levels are descriptive rather than normative and technical rather than legal. Elements indicate minimum rather than maximum capabilities for each level.

"System" refers to the driver assistance system, combination of driver assistance systems, or *automated driving system*, as appropriate.

The table also shows how SAE's levels definitively correspond to those developed by the Germany Federal Highway Research Institute (BAST) and approximately correspond to those described by the US National Highway Traffic Safety Administration (NHTSA) in its "Preliminary Statement of Policy Concerning Automated Vehicles" of May 30, 2013.

Level	Name	Narrative definition	Execution of steering and acceleration/ deceleration	Monitoring of driving environment	Fallback performance of <i>dynamic driving task</i>	System capability (<i>driving modes</i>)	BAST level	NHTSA level
Human driver monitors the driving environment								
0	No Automation	the full-time performance by the <i>human driver</i> of all aspects of the <i>dynamic driving task</i> , even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a	Driver only	0
1	Driver Assistance	the <i>driving mode</i> -specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the <i>human driver</i> perform all remaining aspects of the <i>dynamic driving task</i>	Human driver and system	Human driver	Human driver	Some driving modes	Assisted	1
2	Partial Automation	the <i>driving mode</i> -specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the <i>human driver</i> perform all remaining aspects of the <i>dynamic driving task</i>	System	Human driver	Human driver	Some driving modes	Partially automated	2
Automated driving system ("system") monitors the driving environment								
3	Conditional Automation	the <i>driving mode</i> -specific performance by an <i>automated driving system</i> of all aspects of the <i>dynamic driving task</i> with the expectation that the <i>human driver</i> will respond appropriately to a <i>request to intervene</i>	System	System	Human driver	Some driving modes	Highly automated	3
4	High Automation	the <i>driving mode</i> -specific performance by an <i>automated driving system</i> of all aspects of the <i>dynamic driving task</i> , even if a <i>human driver</i> does not respond appropriately to a <i>request to intervene</i>	System	System	System	Some driving modes	Fully automated	3/4
5	Full Automation	the full-time performance by an <i>automated driving system</i> of all aspects of the <i>dynamic driving task</i> under all roadway and environmental conditions that can be managed by a <i>human driver</i>	System	System	System	All driving modes		



California's Definition of Autonomous Vehicle

- An autonomous vehicle **does not include** a vehicle that is equipped with one or more collision avoidance systems, including, but not limited to, electronic blind spot assistance, automated emergency braking systems, park assist, adaptive cruise control, lane keep assist, lane departure warning, traffic jam and queuing assist, or other similar systems that enhance safety or provide driver assistance, **but are not capable**, collectively or singularly, of driving the vehicle without the active control or monitoring of a human operator.



California's Definition of Autonomous Vehicle

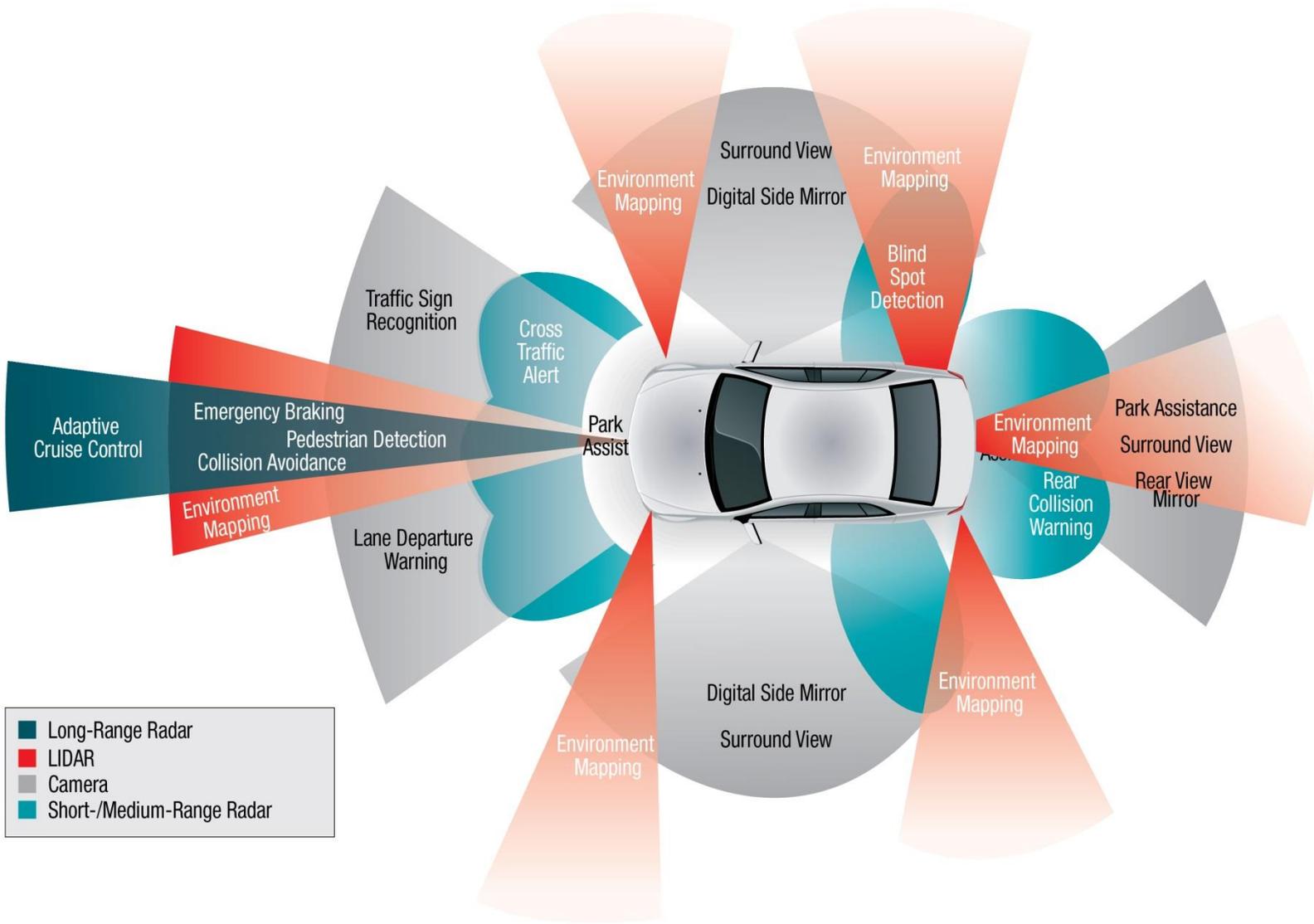
- A vehicle, equipped with autonomous technology, that has the capability to drive without the active physical control or monitoring by a human operator





Examples of Autonomous Vehicles





- Long-Range Radar
- LIDAR
- Camera
- Short-/Medium-Range Radar





Autonomous Vehicles



Philosophical differences

- Driver is essential to vehicle operations
 - Design systems to maintain situational awareness
 - Adequate notification time (Human machine interface – HMI)
 - Human is the backup system
- Vehicle operations fully autonomous
 - No need for steering or braking controls
 - Redundancy and fail-safe built into system

Technological differences

Self-contained processing

Map dependency and cloud computing

Vehicle to vehicle communication (v2v)

NHTSA decision on DSRC capability

Vehicle to infrastructure communication (v2i)

Other forms of autonomous vehicles

- Platooning
- Low speed shuttles









Statewide Steering Committee and Partners





Testing Regulations Summary



- \$5 million in insurance, bond, or self-insurance
- Test driver requirements:
 - No DUI, not an at-fault driver, and no more than 1 point
 - Successful completion of test driver training program
 - Employee, contractor, or designee of manufacturer
- Test driver must be seated in driver seat during testing
- Report any accident within 10 days
- Report unanticipated disengagements of autonomous technology annually
- Testing permit valid for one year
- Vehicles excluded from testing:
 - Commercial vehicles
 - > 10,000 lbs GVW
 - Motorcycles



Approved Testing Permits



Mercedes-Benz



TESLA MOTORS



HONDA



BOSCH
Invented for life





Reported Accidents



Fifteen crashes since testing permits issued



- 12 reports



- 1 report



- 1 report



- 1 report

Reports are available on DMV's website:

https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/autonomouseveh_ol316



Reported Disengagements

- Bosch reported 625 disengagements in 935 miles driven.
- Delphi reported 405 disengagements in 16,662 miles driven.
- Google reported 341 disengagements in 424,331 miles driven.
- Nissan reported 106 disengagements in 1,485 miles driven.
- Mercedes-Benz reported 967 disengagements in 1,337 miles driven.
- Tesla Motors reported zero disengagements (No testing on public streets)
- Volkswagen/Audi reported 260 disengagements in 14,945 miles driven.



Deployment Regulations Challenges

- Definition
- Safety
- Liability
- Privacy
- Cybersecurity
- Operational Design Domain
- Reliability
- Infrastructure
- Software updates
- Law enforcement
- Usage
- Vehicle Code
- Visibility
- Standardization
- Insurance
- Technical constraints
- Licensing
- Public perception
- Vehicle platform
- Secondary market



Draft Components of Deployment Regulations

Theme: Necessary to ensure safe operation on public roads

- Independent 3rd party certification of a vehicle's performance relative to a specified set of behavioral competencies.
- Exclude autonomous vehicles capable of operating without the presence of a driver.
- Operators must be a licensed driver, responsible for monitoring the safe operation of the vehicle.
- Manufacturers initially issued a three-year deployment permit. Autonomous vehicles may be made available to the public on no more than a lease basis.
- During deployment period, collect and report on performance, safety, and usage of autonomous vehicles.



Feedback

- Requirement for a licensed driver in the vehicle prevents the disabled community from reaping benefits of AVs.
- The U.S. relies on self certification and a rigorous NHTSA recall process – the third party demonstration test is not necessary.
- Regulations are ambiguous because they don't establish the standards for a third party.
- Why limit deployment to just leasing the vehicles?
- The data companies collect and are required to report could be sensitive trade secrets.
- Regulations should anticipate and allow for a future state when driverless autos are safe for deployment
- Requiring a licensed driver in the autonomous vehicle for the time being is prudent.
- Minimum testing miles not a viable measure of safety.



Outreach Efforts



Dear Bernad Soriano,
Thank you so much for
coming to Bohannon
Middle school's collage
career Day and
talking to us about
your career! Something
I learned from you
is what you have to
do to become an
engineer. One thing
that impressed me
about your career
is how you work

ON SELF driving
cars. Because of
your presentation,
I have decided to
become a Lawyer.
I really appreciated
you coming.

Sincerely,
Alejandro



For More Information Contact:

Bernard.Soriano@dmv.ca.gov

(916) 657-7626

Linked ™



@Bernard45